REMARKS

Claims 1-12 were originally filed. Claims 1-12 stand rejected. Claims 1, 3, and 7-12 were amended. Claims 13-26 were added. Claims 1-26 remain in the application.

Claim 12 stands rejected under 35 U.S.C. 101 and has been corrected.

Claims 1-2 and 12 stand rejected under 35 U.S.C. 102(b) as being anticipated by Murayama (US Patent 5,936,684). The rejection states, in relation to Claims 1 and 12:

> "Regarding claims 1 and 12: Murayama discloses determining M reconstruction levels (M<N) based on the gray level distribution of the N level image (figure 4 and column 9, lines 34-39 of Murayama); and applying multilevel dithering to the N level digital image using the M reconstruction levels to produce the M level digital image (figures 8-9 and column 12, lines 5862 of Murayama)."

Claim 1 states:

> 1. A method for multitone processing an N level digital image to produce an M level digital image wherein M<N, comprising the steps of:
>
> a) determining M reconstruction levels based on the gray level distribution of the N level image, each said reconstruction level being calculated using respective pixels of said N level image; and
>
> b) applying multilevel error diffusion to the N level digital image using the M reconstruction levels to produce the M level digital image.

Claim 1 requires that each of of M reconstruction levels is calculated using respective pixels of the N level image. This contrasts with Murayama, in which thresholds are used, a first threshold is calculated from a set of pixel values, and additional thresholds are calculated from the first threshold:

> "Next, in step s4 of FIG. 1, other threshold values are determined based on this first threshold value th[1]." (Murayama, col. 8, lines 23-24; see also col. 9, lines 34-38; see also the Office Action, page 3, discussion of Claim 2.)

Claim 1 also requires applying multilevel error diffusion using the calculated reconstruction levels. Murayama teaches using the above-described threshold values with dithering and, alternatively, with error diffusion, and teaches that dithering is preferred. (Murayama, col. 4, lines 10-17; col. 6, lines 15-22; col. 14, lines 56-62) This teaches against the claimed invention.

Claim 12 is allowable as depending from Claim 1.

Claim 2 is allowable as depending from Claim 1 and as follows. The rejection states:

"Regarding claim 2: Murayama discloses performing a K-means clustering operation on the N level digital image, wherein K=M (column 8, lines 37-43 of Murayama). The number of cumulative pixels for increasing brightness in the histogram (figure 2b of Murayama) are used to determine the threshold values (column 8, lines 39-43 of Murayama). The total number of cumulative pixels are divided by the number of levels (M, or n in Murayama) that are used for the image reconstruction (column 8, lines 37-38 of Murayama), and thus the number of clusters (K) is equal to the number of reconstruction levels (M)."

Claim 2 requires performing a K-means clustering operation, in which K = M. The rejection addresses K = M, but does not address the remainder of the claim. The term "K-means clustering" is defined in the application:

"Referring to Fig. 2, there is shown the steps of the K-means clustering technique. First, the number of clusters K is selected to be equal to M 21. Then initial values for the K cluster centers are chosen 22 either randomly or uniformly spaced in the range of pixel values of the input digital image. Next, each pixel is assigned 23 to the closest cluster center according to the Euclidean distance, which corresponds to minimization of the mean squared error. Cluster centers are then recalculated 24 using all the pixel values assigned to each cluster center. Next, a pre-determined stopping condition is checked 25. One example of a stopping condition is when the changes in the cluster centers are below a predetermined threshold. If the pre-determined stopping condition is not met, steps 23 and 24 are repeated. Otherwise, the K-means clustering process is stopped 26. For more details about the K-means algorithm, see Tou and Gonzalez, Pattern Recognition Principles, Reading MA: Addison-

Wesley, 1974. These K cluster means are used as the M optimal reconstruction levels to produce an M level output image." (application, page 4, line 18 to page 5, line 1; also see Figure 2)

Murayama does not disclose or suggest K-means clustering.

Claims 3-6 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama (US Patent 5,936,684) in view of Ishiguro (US Patent 6,501,566 B1). The rejection states as to Claim 3:

"Regarding claim 3: Murayama discloses forming a histogram of the N level digital image (figure 2a and column 7, lines 26-31 of Murayama).

"Murayama does not disclose expressly locating M levels corresponding to the M most prominent peaks in the histogram.

"Ishiguro discloses locating M levels (denoted by N is Ishiguro (column 3, lines 24-25 of Ishiguro)) corresponding to the M most prominent peaks in the histogram (figure 7 and column 7, lines 23-26 and lines 59-65 of Ishiguro). A histogram is created (figure 7 and column 7, lines 23-26 of Ishiguro) which set the pixel reference levels based on the number of pixels with densities within a set range (figure 7 and column 7, lines 59-65 of Ishiguro). As can clearly be seen from figure 7 of Ishiguro, this results in the four density levels (SO to S3) corresponding to the four most prominent peaks in the histogram. This is further evidenced by the language of claim 14 of Ishiguro (column 10, lines 57-60 of Ishiguro).

"Murayama and Ishiguro are combinable because they are from the same field of endeavor, namely digital image binarization. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to set the M levels (M<N), taught by both Murayama and Ishiguro, based on the M most prominent peaks of said histogram, as taught by Ishiguro. The motivation for doing so would have been to prevent degradation of the image quality when error diffusion is performed, which is a common result for predetermined threshold values (column 2, lines 57-65 of Ishiguro). Therefore, it would have been obvious to combine Ishiguro with Murayama to obtain the invention as specified in claim 3."

Claim 3 has been rewritten as an independent claim and now states:

3. A method for multitone processing an N level digital image to produce an M level digital image wherein M<N, comprising the steps of:

a) determining M reconstruction levels based on the gray level distribution of the N level image; and

b) applying multilevel error diffusion to the N level digital image using said M reconstruction levels to produce the M level digital image;

wherein the determining step comprises forming a histogram of the N level digital image and locating said M reconstruction levels corresponding to the M most prominent peaks in the histogram.

Murayama and Ishiguro do not combine to teach the claimed invention. Murayama and Ishiguro teach two different types of histograms. Murayama teaches the setting of thresholds based upon a cumulative frequency distribution as shown by the cumulative histogram of Figures 2(a) and 2(b). (Murayama, col. 6, lines 42-44; col. 7, lines 25-27) Ishiguro discloses setting a threshold using a non-cumulative histogram of pixel densities. (Isihiguro, col. 7, lines 23-26) Murayama uses the cumulative frequency distribution of the cumulative histogram to meet the object of the invention of Murayama:

"Hence, it is an object of the invention to provide an image processing method and apparatus which can set threshold values for achieving a desired number of gradations, i.e., color shades or gray-scale, via a simple process when an image processed with a high number of gradations is displayed on a display unit having a low number of gradations, and can set the desired numberr of gradations without shading being noticeable, even for images having shading.

"In order to achieve the above objects, the image processing method of the invention is of the type of image processing method wherein image data, having a brightness range in designated gradations and including at least a background and meaningful inforamtion existing in the background, is converted to image data in n gradations (n>2), with n differeing from the designated gradations. The cumulative frequency distribution of the pixels is determined for each brightness range in the designated gradations. The average brightness and

standard deviation of the part wherein the background is predominant are determined from this cumulative frequency distribution. A first theshold value that is an indicator of the boundary between the background and the meaningful information is determined on the basis of the average brightness and standard deviation." (Murayama, col. 2, lines 16-39; emphasis added)

In Ishiguro the theshold can be changed, as desired:

"Furthermore, the pixel of a particular density can be enhanced or the number of out gray levels can be adjusted by intentionally altering the condition for setting the threshold value (for example, by arbitrary setting by user)." (Ishiguro, col. 9, lines 31-35; emphasis added)

Assuming that one of skill in the art were motivated to combine Murayama and Ishiguro, the above-quoted portions to those references would provide motivation to use the process of Ishiguro with thresholds set by the cumulative frequency distribution and cumulative histogram of Murayama. This contradicts the rejection, which proposes the opposite.

The cited motivation for combining Ishiguro with Murayama is to prevent degradation of the image quality when error diffusion is performed as described at Ishiguro, col. 2, lines 57-65:

"However, the conventional multi-value error diffusion process circuit had the disadvantage that the quality of the image data is degraded since the entire original document is subjected to the error diffusion process with a predetermined threshold value. For example, when there is a halftone image of uniform density in the original data such as halftone density text and that uniform density differs from the predetermined threshold value, data resolution is reduced to degrade the picture quality of the image." (emphasis added)

This is a quotation from the Background of the Invention of Ishiguro that presents a problem in the prior art. Ishiguro then a solution:

"An object of the present invention is to provide a image processing apparatus that can carry out an error diffusion process without degrading the quality of the image data." (Ishiguro, col. 3, lines 9-11; emphasis added)

-10-

Ishiguro states that the problem cited by the rejection is solved by the invention of Ishiguro. Why would one of skill in the art be motivated to ignore that solution in favor of an untried combination of Ishiguro and Murayama?

Claims 4-6 are allowable as depending from Claim 1.

Claim 7 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Eschbach (US Patent 5,565,994). Claims 8 and 10-11 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Eschbach and Klassen (US Patent 5,621,546). Claim 9 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama in view of Klassen.

Claims 7-11 are allowable as depending from Claim 1. Claims 7-11 were amended to track the language of Claim 1 and provide uniform nomenclature.

Added Claims 13-15 are supported by the application as filed, notably the original claims and page 5, lines 5-11. Claims 13-15 are allowable as depending from Claim 13.

Added Claim 16 states:

16. A method for multitone processing an N level digital image to produce an M level digital image wherein M<N, comprising the steps of:

clustering pixel values of the N level image into M reconstruction levels based on the gray level distribution of the N level image;

minimizing error between the N level digital image and the M level digital image during said clustering; and

applying multilevel error diffusion to the N level digital image using said M reconstruction levels to produce the M level digital image.

Claim 16 is supported by the application as filed, notably the original claims and at page 4, lines 8 to page 5, line 1.

Claim 16 requires minimizing error between the N level digital image and the M level digital image while clustering pixel values of the N level image into M reconstruction levels based on the gray level distribution of the N level image. This contrasts with Murayama and Ishiguro. Murayama calculates

thresholds on the basis of an average brightness and standard deviation of a part of the image. Ishiguro discloses averaging reference densities to determine thresholds. (Ishiguro, col. 8, lines 35-37)

Added Claims 17-20 are supported by the application as filed, notably the original claims, and are allowable as depending from Claim 16.

Added Claim 21 states:

21. A method for multitone processing an N level digital image to produce an M level digital image wherein M<N, comprising the steps of:

setting initial values of M cluster centers;

assigning pixels of the N level digital image to said cluster centers to provide assigned pixels;

calculating new values of said cluster centers based upon respective said assigned pixels;

repeating said assigning and calculating until a predetermined stopping condition is reached and, thereby, final values of said cluster centers are defined;

selecting said final values of said cluster centers as reconstruction levels; and

applying applying multilevel error diffusion to the N level digital image using said reconstruction levels to produce the M level digital image.

Claim 21 is supported by the application as filed, notably the original claims and at page 4, lines 8 to page 5, line 1.

Claim 21 requires setting initial values of M cluster centers, assigning pixels to the cluster centers, calculating new cluster center values, and repeating the process until stopping condition is reached and using the resulting final values of the cluster centers as reconstruction levels that are then applied. This contrasts with Murayama and Ishiguro. (See the above discussion Murayama and Ishiguro in relation to Claim 16.)

Added Claims 22-26 are allowable as depending from Claim 21. Claims 22 and 23 are also supported and allowable on the same grounds as Claim 21. Claims 24-26 are supported by the application as filed, notably the original claims.

It is believed that these changes now make the claims clear and definite and, if there are any problems with these changes, Applicants' attorney would appreciate a telephone call.

In view of the foregoing, it is believed none of the references, taken singly or in combination, disclose the claimed invention. Accordingly, this application is believed to be in condition for allowance, the notice of which is respectfully requested.

Respectfully submitted,

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If the Examiner is unable to reach the Applicant(s) Attorney at the telephone number provided, the Examiner is requested to communicate with Eastman Kodak Company Patent Operations at (585) 477-4656.